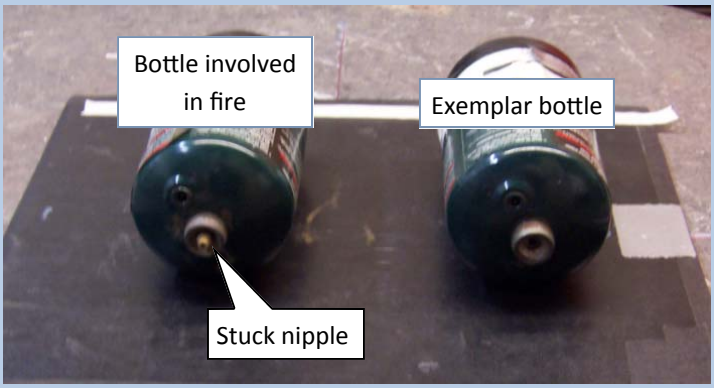
Woman burned by propane camp stove

A caterer serving firefighters north of Los Angeles suffered burns when the propane bottle she unscrewed from a camp stove continued to release propane after its disconnection from the stove. When she unscrewed the bottle, the brass nipple that belongs to the stove unscrewed and stayed lodged in the bottle. This prevented the Schrader valve in the propane bottle from closing and sealing off the propane.

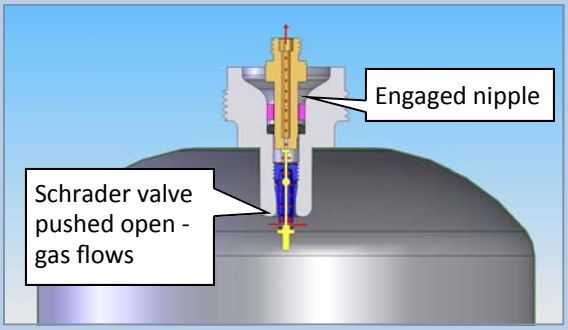


Bottle involved in fire (left) and exemplar bottle (right). Here the bottles are being X-rayed to try to determine what is holding the nipple in.

This case was interesting because the nipple remained lodged in the propane bottle, and it was impossible to determine what prevented it from being withdrawn. We held an investigation in a lab where we could pull on the nipple with a measurable force to extract it. Even with a force up to 30 lbs, we were unable to extract the nipple. We took the nipple to a firm that does industrial X-rays, mainly for assessing weld quality. Though we could "see" inside the bottle, we were still unable to determine why the nipple was still lodged in the bottle.

We bought comparable stoves and measured the torque that was needed to unscrew the nipple from the stove. We also looked at the profiles of the nipple of a duplicate stove and discovered that it had sharp corners that could actually cut the sealing O-ring of the bottle that fit around the nipple. So our suspicion was that a piece of O-ring had been cut off and somehow lodged itself around the nipple, preventing its extraction. A component such as a nipple turned on a lathe should have its sharp edges removed.

We made a solid model of the bottle and the Schrader valve that closes it off when it disengages from the stove. We used solid modeling to show how the stove nipple interfaces with the propane bottle. This was all done to visualize this interface and try to figure out what could be holding the nipple into the bottle.



Propane bottle with engaged nipple.

Additionally we ran a battery of tests in a lab with exemplars and also with the hardware involved in the fire. A female-threaded coupling piece screws onto the neck of the propane bottle. The stove nipple is screwed into this coupling. To prevent the nipple from unscrewing out of this female piece, it should be firmly locked into it. One method of doing this would be to use left-handed threads on the nipple, so that unscrewing the coupling from the bottle neck would actually cause the nipple to be tightened in the coupling. Or some thread lock like Loctite could be applied to the threads of the nipple. At the very least there should be a somewhat large torque needed to unscrew the nipple from the coupling. What we found in the lab was that none of these measures had been taken. The threads were right-hand threads on the nipple, and there was no evidence of a thread-locking compound on the nipple threads. We used a calibrated torque wrench to unscrew the nipples from the mating coupling on several exemplar stoves we had bought at local stores.. The breaking torque to remove these nipples was very low. This indicated to us that the design was flawed, that it was not all

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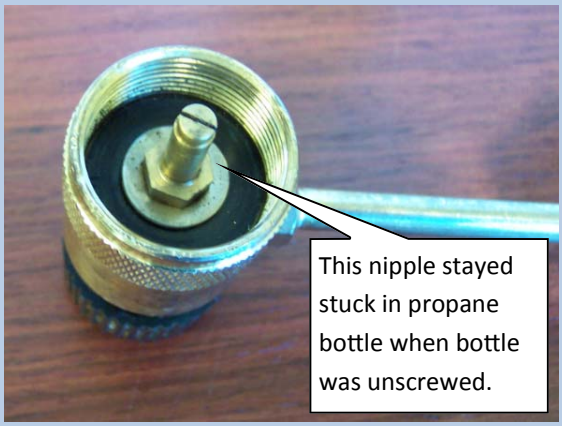
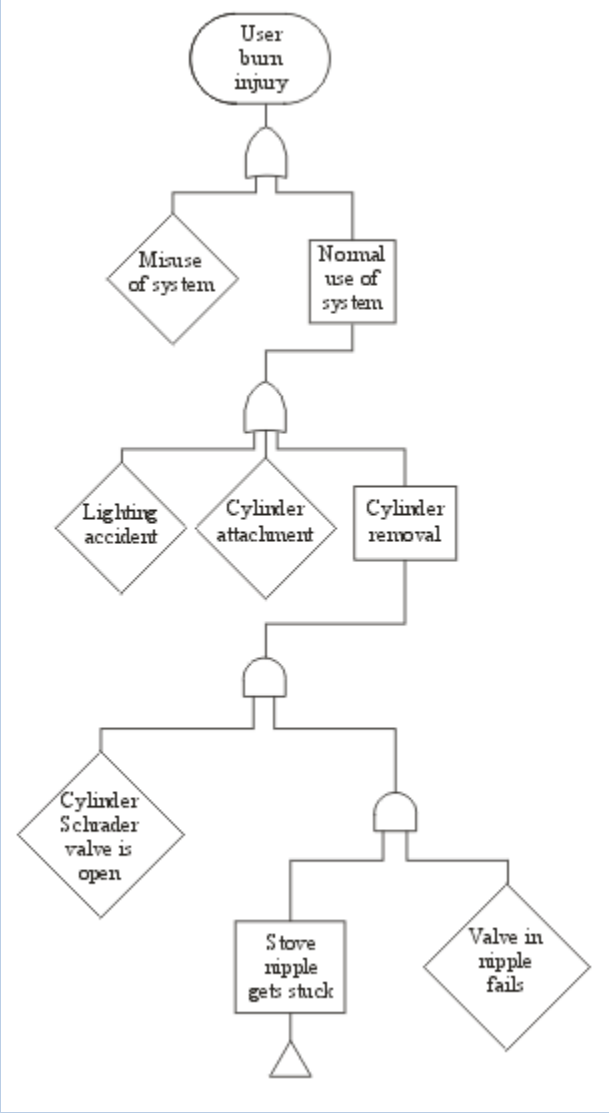
that hard to have a nipple remain in the bottle when the bottle was unscrewed, allowing gas to leak out into the atmosphere.

By making the solid model , we noticed that the nipple on the exemplar stoves had some sharp edges that actually could cut the sealing O-rings in the bottle. Good engineering practice would suggest that these edges should be rounded or "chamfered" to reduce the likelihood of this. We speculated that the sharp edges had cut an O-ring and that a piece of O-ring had gotten lodged between the nipple and the bottle outlet, causing it to get stuck and stay connected to the bottle when the bottle was unscrewed.



Stove fitting showing nipple piece that became unscrewed from fitting and stayed with mating propane bottle when bottle unscrewed from stove.

We also made a *fault tree* of this accident, showing the steps that led up to it and the causal chain of events that, if broken, would have prevented the accident from happening.



Fault tree of burn event.

Another interesting aspect of this case was that the stove was manufactured by some knock-off firm in China. We tried to trace its design lineage to determine why the nipple was designed the way it was and to see if any value had been given for tightening torque for the nipple. We were unable to find design documents for the stove, such being a consequence of globalization and the vast manufacture of cheaply engineered items from China.

This case was settled out of court to the advantage of the burn victim. Engineering design knowledge and in-depth knowledge of machining processes for turned components enabled this outcome.

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